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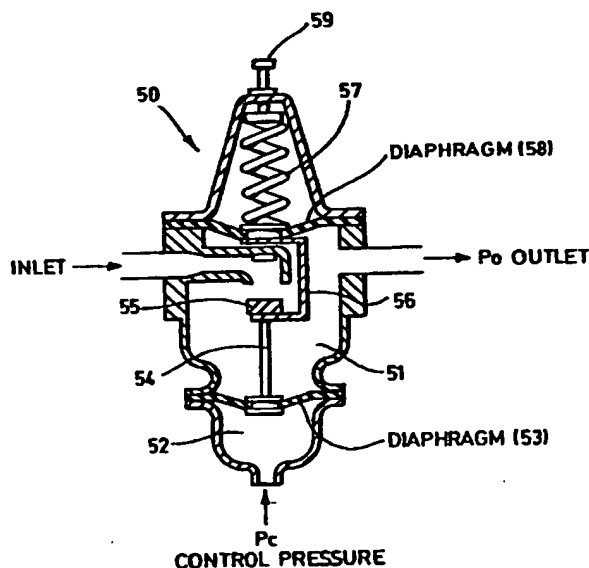
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- (71) Applicant (*for all designated States except US*): TECHNOLOG LIMITED [GB/GB]; Ravenstor Road, Wirksworth, Matlock, Derbyshire DE4 4FY (GB).
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- (72) Inventor; and
(75) Inventor/Applicant (*for US only*): YONNET, Claude [FR/GB]; The Home Close, 36 Edge Road, Matlock, Derbyshire DE4 3NH (GB).
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: PILOT VALVE



(57) Abstract: There is provided a pilot valve (50), suitable for use in water and gas supply systems, the valve including biasing means (57), to control a gate (55), for controlling fluid flow through a control chamber (51), and a second chamber (52), which is sealed by a diaphragm (53), the second chamber (52), in use, receiving a control pressure for controlling the operation of the gate (55), such that an increase in control pressure acts to reduce fluid flow through the gate (55). The side of the diaphragm (53), against which the control pressure is not applied, is in fluid communication with the control chamber (51).

PILOT VALVE

The present invention relates to a pilot valve, for example of the type which is commonly used to control a pressure reducing valve in water and gas supply systems.

Figure 1 illustrates the use of a "single chamber" pilot valve 1 to control a pressure reducing valve (PRV - shown schematically as item 2) as commonly used in a water supply system. In the context of a gas supply system such a pressure reducing valve is normally known as a "regulator" or "governor", but herein the single term "PRV" is used for simplicity as referring to both types of system. The fluid to be controlled (usually water or gas, and in this example will be taken to be water) flows along the main pipe 3 through the PRV. The outlet pressure (P_o) is usually less than the inlet pressure (P_i) due to the action of the PRV.

The amount of pressure reduction is controlled by operation of the PRV under control of pilot valve 1. An auxiliary flow pipe 4 carries water from the inlet of the PRV to the control chamber 5 of the pilot valve 1 and then back to the outlet of the PRV. Prior to entering the control chamber 5, the water passes through a venturi chamber (or primary orifice) 6 or, more correctly in the context of a gas supply system, an inspirator 6 and the

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water pressure (P_v) at the outlet side 7 of the chamber or inspirator controls the PRV.

The flow of water through the control chamber 5 is controlled by a gate mechanism 8 which is linked to a diaphragm 9. A spring 10 applies force to the rear of the diaphragm 9 and the amount of force supplied by the spring may be varied by an adjustment screw 11.

10 In a steady state situation (where P_o remains constant) the water pressure in the control chamber 5 will be balanced by the force generated the spring and the gate 8 will remain in a constant position. Thus the flow through the auxiliary pipe 4 will remain constant and P_v 15 will remain constant.

If the control pressure (P_o) falls, the spring 10 causes the gate 8 to open further and the flow through the auxiliary pipe increases. Accordingly, the flow through 20 the venturi 6 also increases which results in pressure P_v decreasing, causing the PRV to open further. This results in the control pressure P_o rising again and the system should then reach a steady state again at the previously set value of P_o .

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In order to provide an improved control system, the present applicant has already disclosed a system which

uses a "dual chamber" pilot valve in European Patent No. 574241. Figure 2 shows an example of a system utilising a "sandwich plate" dual chamber pilot 20. The pilot valve 20 performs the same general function in the control system as the pilot valve of Figure 1 but in this example the adjustment previously provided by adjustment screw 11 is effectively supplemented by an adjustment using a control pressure (P_c). As further relevant background art may be mentioned the gas supply pressure control apparatus as disclosed by the present applicant in GB-A-2252848.

The pilot valve 20 includes a second chamber 21 which is effectively divided into two portions 22 and 23 by a wall 24. The control pressure P_c effectively acts against the force of spring 10 by virtue of diaphragm 26. As with Figure 1, the spring is mechanically connected by arm 28 to a gate mechanism 8 which performs the same function as previously. The arm 28 passes through wall 24 and the aperture through which it passes is sealed by a seal 29 so that chamber 23 does not contain any water but instead is vented to the atmosphere.

If the control pressure P_c remains constant, then the system operates as explained with reference to Figure 1. However, if the control pressure P_c is reduced then the gate 8 will open further thereby reducing pressure P_v and increasing the outlet pressure P_o . This is usually

referred to as a "failsafe" system since in the event that the control pressure fails i.e. fails to zero, the outlet pressure P_o will be set to its maximum value.

5 Figure 3 illustrates an alternative but mechanically equivalent "dual chamber" pilot valve arrangement to that shown in Figure 2. The arrangement of Figure 3 is sometimes referred to as a "pancake adapted" pilot. In this arrangement, the second chamber 31 is located at the
10 base of the pilot 30. As with the arrangement of Figure 2, the second chamber 31 is divided by a diaphragm 34 into two chambers 32 and 33 and the control pressure P_c is applied to chamber 32. The diaphragm 34 is mechanically linked via an arm 35 to the gate mechanism 8 but is not
15 rigidly limited to the gate or spring. The arm 35 presses into control chamber 5 via an aperture which is again sealed with seal 36.

In the embodiment of Figure 3, the control pressure
20 P_c again opposes the force produced by the spring 10 and so the control system effectively operates in an identical manner. In other words, if control pressure P_c is reduced then the outlet pressure P_o is increased.

25 One advantage over the Figure 3 arrangement as opposed to the Figure 2 arrangement is that the additional chamber 31 can effectively be retrofitted to a single

chamber pilot valve. However one disadvantage with the dual chamber pilot valves of Figures 2 and 3 is that in both cases a seal needs to be provided in order that the control fluid is prevented from entering the second part of the additional chamber i.e. that part of the chamber to which the control pressure is not applied. The provision of such a seal can be difficult and deterioration or failure of the seal may lead to reduction in performance of the pilot valve or leakage therefrom. Furthermore, the friction caused by the seal can in turn create a frictional error in the quality of the pilot valve control.

Figure 4 shows a further "hydraulic" dual chamber pilot valve arrangement. As with the previous embodiments, a second chamber 40 is provided which is divided by a diaphragm 41 into two parts 42 and 43. The control pressure P_c is applied to part 42 of the second chamber 40 and part 43 is connected to the spring chamber which is vented to the atmosphere. As before, the diaphragm 41 is mechanically connected to the gate 8, in this case via the spring 10.

However, unlike the embodiments of Figure 2 and Figure 3 in the embodiment of Figure 4 the control pressure P_c acts in the same direction as the force of the spring 10, rather than against it. This means that the

control system works in the opposite way to that of
Figures 2 and 3 i.e. if the control pressure P_c is reduced
then the gate 8 closes further, the venturi pressure P_v
increases causing the PRV to close further and the outlet
5 pressure to drop. This arrangement is not considered to
be "failsafe" since a loss of control pressure P_c would
result in the lowest possible outlet pressure P_o . This is
sometimes referred to as a "direct acting" control system
rather than the "reverse acting" control systems of
10 Figures 2 and 3.

The present invention aims to provide a pilot valve
of the "reverse acting" type but which eliminates the need
for a seal.

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In a first aspect, the present invention provides a
pilot valve which includes

biassing means to control a gate for controlling
fluid flow through a control chamber;

20 a second chamber sealed by a second chamber diaphragm
into which control pressure is applicable for also
controlling the operation of the gate, whereby in use an
increase in control pressure acts to reduce fluid flow
through the gate;

25 wherein the side of the diaphragm against which the
control pressure is not applied is in fluid communication
with the control chamber.

In this way, a "reverse acting" dual chamber pilot valve is provided in which the need for any seal in association with the second chamber is avoided.

5 The fluid which in use flows through the control chamber may or may not be the same fluid or type of fluid as the fluid which in use is used to apply the control pressure. The fluids in question may, for example, be water or gas. In other words, in one example both fluids
10 in question may be water; in another example both fluids may be gas; in a third example one fluid may be water and the other gas.

Preferably, the biasing means is a spring means or
15 spring such as a helical spring. Preferably the biasing means is biased to open the gate and may be rigidly connected to the gate by a suitable mechanical linkage. Preferably the diaphragm is also rigidly connected to the gate and/or biasing means via the same or a second
20 suitable mechanical linkage.

Preferably, the control chamber is at least partly bounded by a control chamber diaphragm in addition to the second chamber diaphragm. Preferably biasing means is
25 located on the opposite side of the control chamber diaphragm to the control chamber. As will be explained in detail later in the specification, by appropriately

selecting the areas of the second chamber diaphragm and the control chamber diaphragm, the effect of the control pressure on the fluid flow through the control chamber (and therefore in use, on the outlet pressure) can be
5 selected.

In a preferred embodiment, the ratio of the area of the control chamber diaphragm to the second chamber diaphragm is 2:1 or less. For example, if the control
10 chamber diaphragm is twice the area of the second chamber diaphragm then a particular drop in control pressure will result in an identical increase in outlet pressure. In a different example, if the area of the second chamber diaphragm is three-quarters that of the control chamber
15 diaphragm then an increase in control pressure of a given amount would cause the outlet pressure to decrease by three times that amount. The particular case in which the second chamber diaphragm area is half that of the control chamber diaphragm effectively replicates the function of
20 the "sandwich" and "pancake" arrangements described earlier with reference to Figures 2 and 3.

Embodiments of the present invention will now be described by way of example with reference to the
25 accompanying drawings in which:

Figure 1 is a schematic diagram of a single chamber

pilot valve control arrangement;

Figure 2 is a schematic diagram of a "sandwich" dual chamber pilot valve arrangement;

Figure 3 is a schematic diagram of a "pancake" dual
5 chamber pilot valve arrangement;

Figure 4 is a schematic diagram of a "hydraulic" dual chamber pilot valve arrangement; and

Figure 5 is a schematic diagram of a pilot valve according to an embodiment of the present invention.

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Figure 5 shows a pilot valve 50 which includes a control chamber 51 and a second chamber 52. A control pressure P_c is applied to chamber 52 in use and chamber 52 is divided from control chamber 51 by a second chamber
15 diaphragm 53.

The second chamber diaphragm 53 is rigidly connected via linkage 54 to a gate mechanism 55. The gate mechanism 55 is also connected via a further rigid linkage 56 to a
20 spring 57. The spring 57 is isolated from the control chamber 51 by the control chamber diaphragm 58. The action of the force of the spring 57 on the diaphragm 58 may be adjusted by adjustment screw 59.

25 As can be seen from Figure 5, the control fluid (which may be gas or water) present in the control chamber 51 acts against the opposite side of the second chamber

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diaphragm 53 to the control pressure P_c . In operation, if, for example, control pressure P_c is reduced then the gate 55 will open further causing the fluid flow through the control chamber to increase. When used in a PRV control circuit, as explained previously, this will cause the outlet pressure to increase.

As indicated in Figure 5, the area of the control chamber diaphragm 59 is designated A and the area of the second chamber diaphragm 53 is designated as A' . The balance of forces operating in the pilot valve is as follows:

$$\begin{aligned} SF &= AP_o - A'P_o + A'P_c \\ &= (A-A')P_o + A'P_c \end{aligned}$$

In a first example, if $A' = \frac{1}{2}A$

$$SF = A'(P_o + P_c)$$

If a "multiplication" effect is required then the relative cross-section areas can be set to a different value. In a second example, if $A' = \frac{3}{4}A$, the equation will be

$$SF = \frac{1}{4}A(P_o + 3P_c)$$

Therefore an increase of P_c of a given amount would

cause P_0 to decrease by three times the amount and vice versa.

The above embodiment is given by way of example only
5 and variations will be apparent to those skilled in the art.

Claims

1. A pilot valve including
biassing means to control a gate for controlling
5 fluid flow through a control chamber;
a second chamber sealed by a second chamber diaphragm
into which control pressure is applicable for also
controlling the operation of the gate, whereby, in use, an
increase in control pressure acts to reduce fluid flow
10 through the gate;
wherein the side of the diaphragm against which the
control pressure is not applied, is in fluid communication
with the control chamber.
- 15 2. A pilot valve according to claim 1 wherein the
biassing means is biased to open the gate.
3. A pilot valve according to claim 2 wherein the
biassing means is rigidly connected to the gate by a
20 mechanical linkage.
4. A pilot valve according to claim 3 wherein the
diaphragm is rigidly connected to the gate by a mechanical
linkage.
- 25 5. A pilot valve according to claim 3 or claim 4
wherein the diaphragm is rigidly connected to the biassing

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means via a mechanical linkage.

6. A pilot valve according to any one of the preceding claims wherein the biasing means is a spring means.

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7. A pilot valve according to claim 6 wherein the spring means is a helical spring.

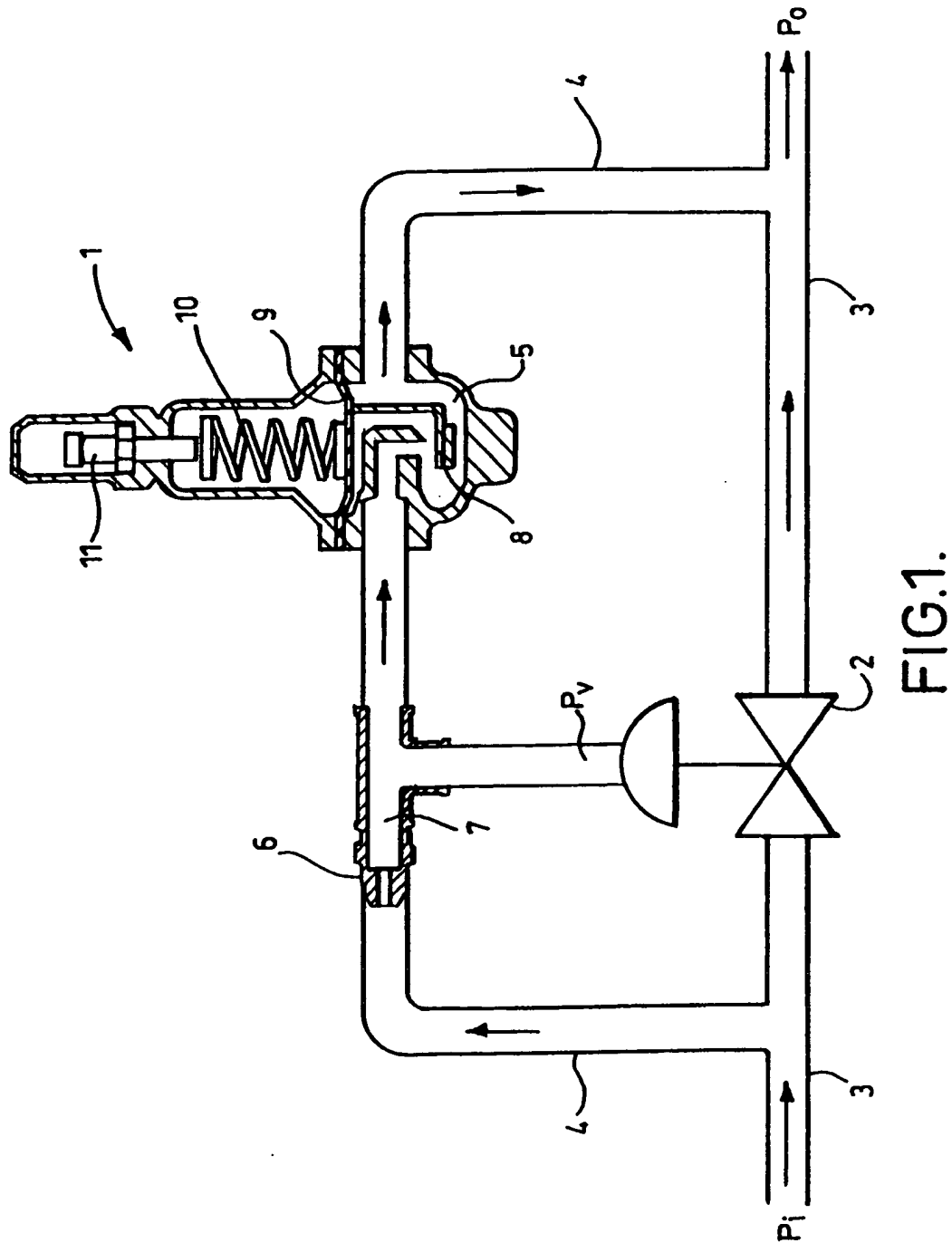
8. A pilot valve according to any one of the preceding
10 claims further including a control chamber diaphragm.

9. A pilot valve according to claim 8 wherein said biasing means is located on the opposite side of the control chamber diaphragm to the control chamber.

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10. A pilot valve according to any one of claims 8 or 9 wherein the ratio of the area of the control chamber diaphragm to the second chamber diaphragm is 2:1 or less.

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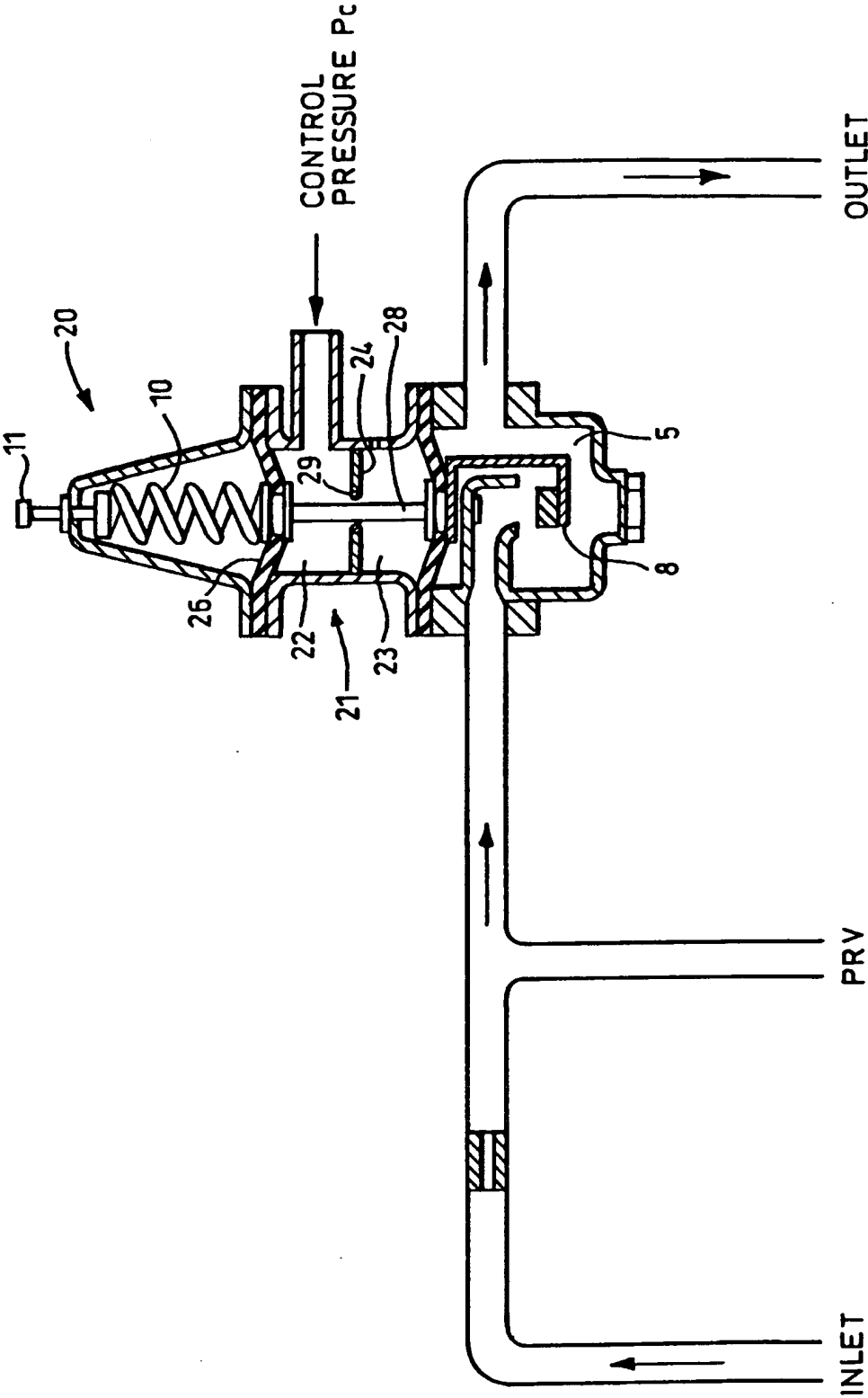


FIG.2.

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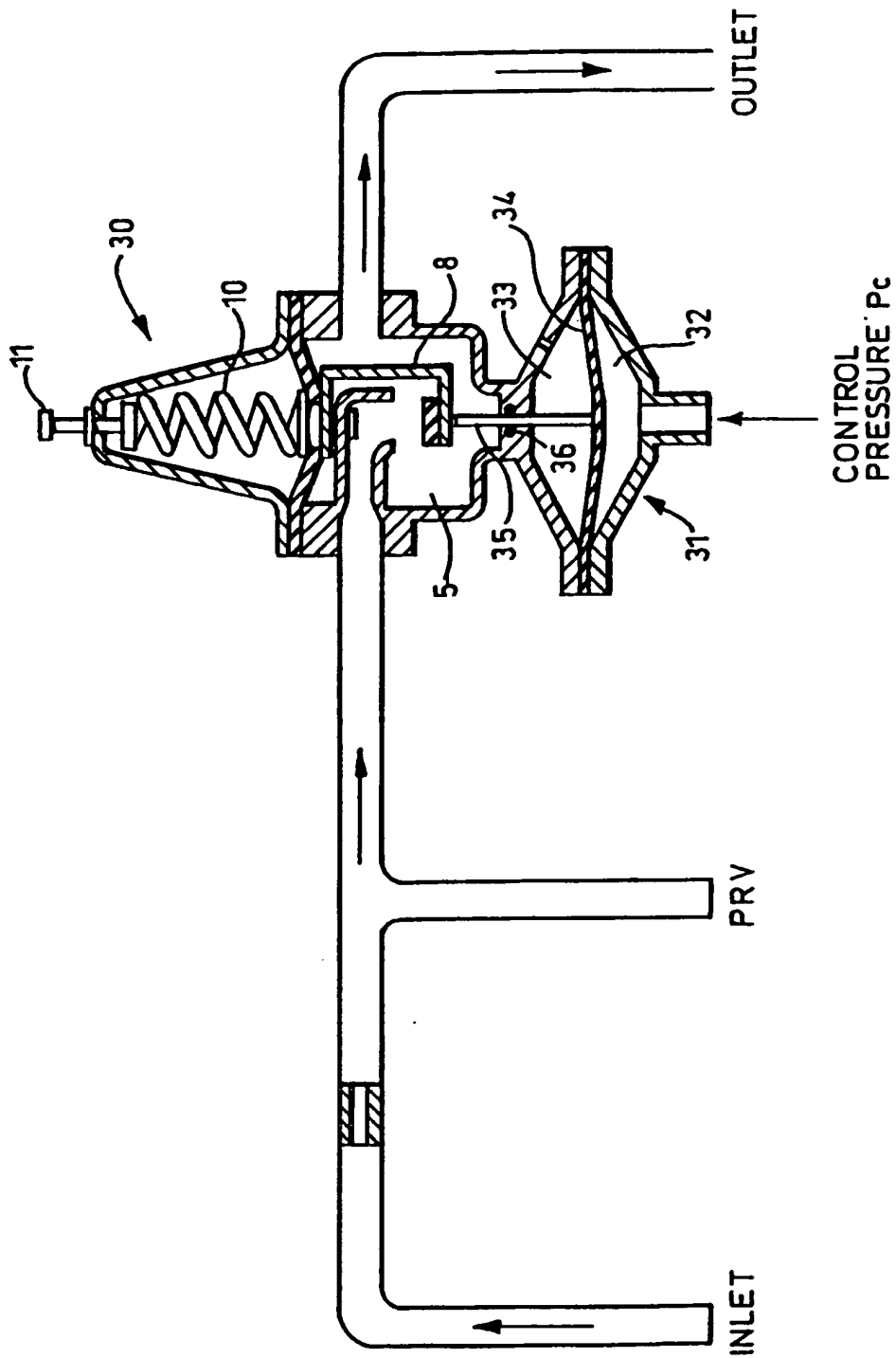


FIG.3.

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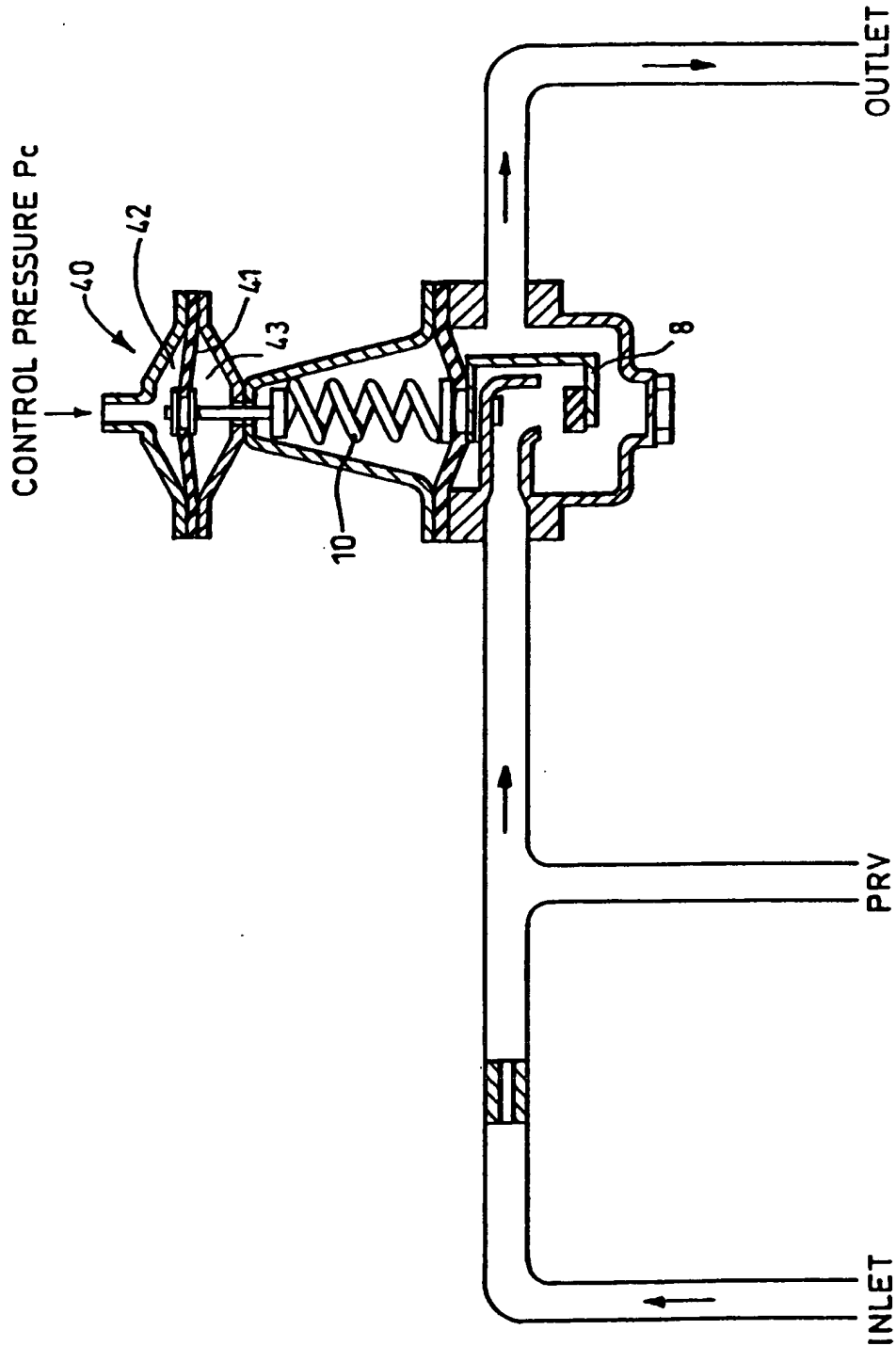


FIG. 4.

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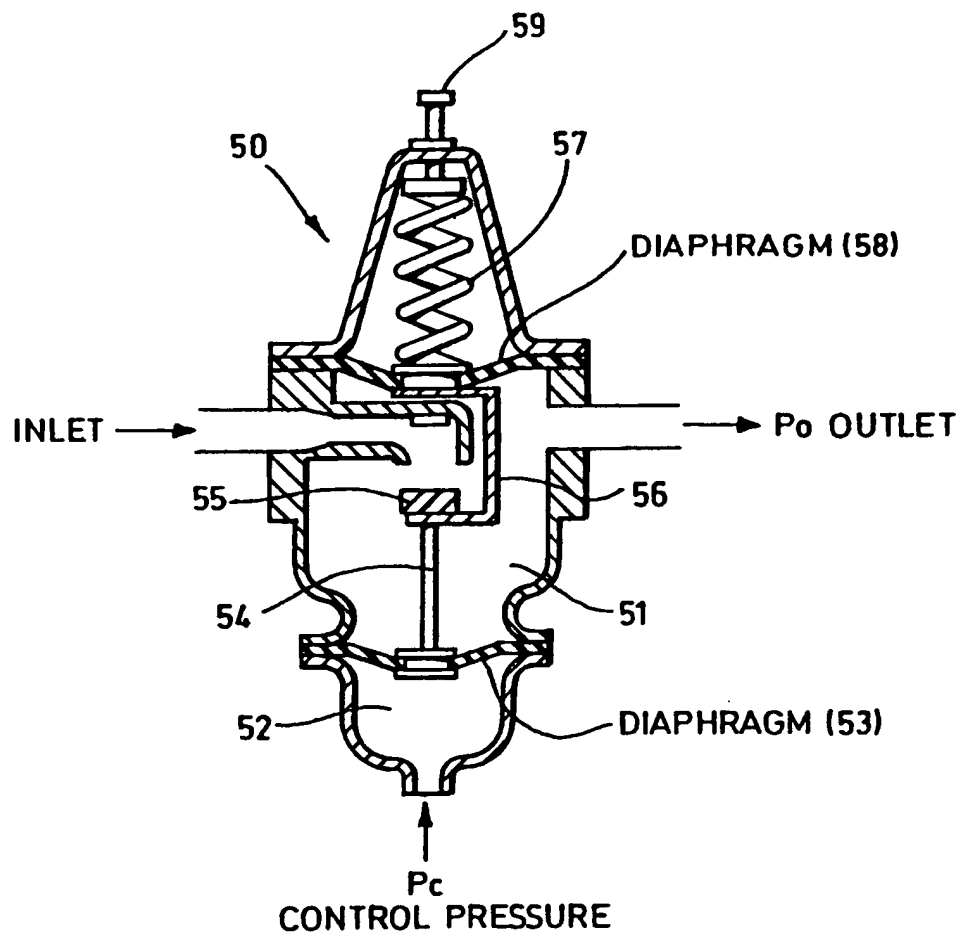


FIG.5.

INTERNATIONAL SEARCH REPORT

Int. Patent Application No

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G05D16/16 G05D16/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G05D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 966 188 A (GARTNER JOSEF ET AL) 30 October 1990 (1990-10-30) the whole document	1-10
X	DE 37 41 364 A (HONEYWELL REGELSYSTEME GMBH) 15 June 1989 (1989-06-15) the whole document	1-10
X	GB 2 284 687 A (DELTA FLUID PRODUCTS LTD) 14 June 1995 (1995-06-14) figure 1	1-7
	-/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Philippot, B

INTERNATIONAL SEARCH REPORT

Int'l. Jona'l Application No

PCT/GB 00/02127

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WKS: "Automatischer Durchflussregler" TECHNISCHE RUNDSCHAU., vol. 62, no. 44, 16 October 1970 (1970-10-16), page 29 XP002147281 HALLWAG VERLAG. BERN., CH ISSN: 1023-0823 the whole document	1-7
X	FR 1 582 851 A (FISHER GOVERNOR COMPANY) 10 October 1969 (1969-10-10)	1,6-10
A	page 2 -page 3 figures 1,2,4	2-5

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. J. Appl. Application No

PCT/GB 00/02127

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4966188 A	30-10-1990	DE 3828002 A GB 2223109 A,B IT 1231495 B NL 8902084 A,B,	22-02-1990 28-03-1990 07-12-1991 16-03-1990
DE 3741364 A	15-06-1989	NONE	
GB 2284687 A	14-06-1995	NONE	
FR 1582851 A	10-10-1969	NONE	